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THE AMERICAN

Meteorological Journal.

VOL. I. DETROIT, JULY, 1884. NO. 3.

EDITORIAL NOTES.

ONE of the earliest notices we have of the sling-psychrometer is in a French journal for 1855, "*Annuaire da la société météorologigue de France.*" We find that it was used by M. L. Doyére for checking the constants of the psychrometric formula developed by Regnault ten years previously.

This instrument has been recently brought into use in this country by H. A. Hazen, of Washington (an article from whom appeared in our June number), and has been also introduced in Germany by Dr. Assmann, a translation of whose paper, published in the April number of the Austrian *Zeitschrift*, we now give elsewhere.

THE question as to what may be considered as the verification of a prediction is a particularly important one in meteorology. For the astronomers it does not present any difficulties. If the astronomer predicts that a planet will occupy a given place at a given time, or that a star of the binary system will complete its orbit at a given date, the decision as to the verification of the prediction is easily and safely made and can not be contested. If the chemist predicts a certain reaction and a given weight of precipitate with a given combination, his prediction can be submitted to the test of fact with ease and certainty. It is not so with meteorology. While in it prediction is especially important, and the verification can be tested by any one, there enters into it the question not only of *what*, but also of *how much*. If cloudiness is predicted for a given time and place, are we justified in accepting a tenth of cloudiness, or nine-

tenths, or what shall be the test? If a storm is predicted, will a slight increase in wind verify? So broad are the limits of the question that there is often, if not generally, a doubt with specific predictions, whether or not they are verified, and it is on this doubt that the popular weather-prophet lives and keeps up his reputation with a good-natured and easily satisfied public.

THE old almanacs used to spread down the page, occupying a good share of a month:

About this
time
look out
for
RAIN.

And if the month was selected in any other way than by lot, the prediction was sure to be verified. This illustrates another difficulty in prediction, and one on which the weather-prophets—including the biped, featherless and feathered, the quadruped, the goose-bone, *et id omne genus*—live. The predictions made by them are either vague in statement, or vague in interpretation, or both, as their necessities may require. The St. Louis "prophet," now deceased, used to give in his almanac fairly exact predictions with dates, but they were accompanied by the statements that, since the predictions were general, a latitude of a good many degrees in space and several days in time must be given him. An indulgent public gave him all he wished and he must have been an extremely unfortunate guesser if he could not have satisfied his self-imposed conditions. It was the same "prophet" who saw the new planet Vulcan when he looked as big as a silver half-dollar. A recent case is that of a Canadian "prophet," who predicted a storm at Halifax and found his verification in an earthquake in England a week or two later.

And yet it will not do to require as great precision in meteorology as can be properly required in the other physical sciences. Astronomy founds its predictions on a single form of energy, gravitation, and even then finds its problems becoming unmanageable except under simple conditions. If the solar system had two suns; if Jupiter had about the mass of the sun; or if the planets were not so far apart, and so small; and if they did not move so nearly in one plane, the problems involved in the prediction of their places might escape the possibilities of our mathematics. The physicist and chemist can predict because they can experimentally reproduce the precise con-

ditions on which they have previously experimented. In meteorology the energies involved are vastly complex and subject to vast and ever-varied perturbations; the conditions of one day are probably never exactly reproduced, and the "signs" of the time will never be followed by exactly the same weather at another time.

To the genuine student of a science of such extreme complexity and extreme importance as meteorology, the greatest possible indulgence should be shown, while to the false "prophet" who lives on vagueness and popular credulity, no such consideration should be given. The difference between the two, lies not so much in their success in predicting a specific phenomenon, as in the scientific character of their investigations and in the continued high average of their verification. The popular "prophet" who attempts to keep his method a secret is probably an impostor. The one who acknowledges his method and gives it to the public with sufficient detail to enable others to test it, should receive respectful attention until it can be ascertained whether he has built his structure on nature or imagination. He should be given a generous hearing until a fair decision can be reached as to the relative amount of fact and fancy involved in his theories. To those whose methods depend on the laborious and long continued study of nature, the test of a high ratio of verification is the final and conclusive one.

But the question recurs, what is a verification? Evidently it is not simply a confirmation, for the confirmation may be only casual. If we predict that a penny when tossed will come down head up, we are as likely as not to be confirmed in our prediction. But the confirmation depends only on probability, and would be just as true if we reversed our prediction. If, however, we were to find a penny somewhat heavier on one side than the other, and predicted on that, we would be able to introduce the law of nature, that the heavier side is apt to be the lower side, and would thus introduce a cause. Our prediction would be no longer casual but causal and its confirmation would be a verification. In other words, the verification is not simply a confirmation of a prediction, it is rather the *causal confirmation*, and in judging of a verification we not only may, but ought to, take into account the method employed in making the prediction. Judged on this definition, what could be a verification for a prediction made in one way would not be a verification for a prediction made in another way. Hence we may define a verification as the confirmation of a precise prediction founded on the known laws of nature.

CURRENT NOTES.

THE rainfall at Cherrapunji, India, (the wettest station known), was 389.82 inches in 1882 and 355.25 inches in 1883.

ADAM SEIDL, an official of the German forest service, who died last December, had made an unbroken series of rain-observations from 1828 to 1883.

DR. MELL, of the Alabama weather service, is making an effort to have weather-signals exposed at all the 400 or more telegraph stations in that state and is hopeful of success.

CELLARS for refuge from tornadoes are being more generally made than ever before. In Georgia, we learn, they are being made with a roof on a level with, or just above, the ground. We fancy they would not afford much security. The roof should be so thick that it can not be torn away by the tornado nor broken in by the débris.

THE study of atmospheric electricity requires long and patient observations before trustworthy results can be obtained. Professor John Trowbridge is carrying on an interesting series of them. His special object, at present. is to ascertain whether it is advisable for the Signal Service to institute simultaneous observations. It may be that experiments will prove that local disturbances will mask general phenomena.

* * THE extraordinary vagaries of the descent of an electric current into a coal mine in the vicinity of Bolton, England, have just been made known. Not long ago, during a thunder-storm, the lightning first struck the chimney at the top of the up-cast shaft at the pit in question, displaced a large quantity of brick work, and descended outside the chimney, striking the ground close to it, and making a large hole. The current then passed along the ground to the cast-plates at the top of the down-cast pit, and, it is presumed, was conducted down the steam pipes, and so into the workings. The shock affected the manager so seriously that he was prostrated for about a week, and a miner, who happened to be standing about a foot away on a tram-rail, had his clog scorched as if hot iron had passed over it. How the electric current finally escaped, or where it spent itself does not appear.—*Elec. Rev.*

THE following press dispatch explains itself. We think the disappointment of the shipping men is justifiable, and that meteorologists will heartily sympathize with them:

SAN FRANCISCO, May 29.—Much anxiety and disappointment is expressed by shipping men over the announcement that the hydrographic office in this city is to be closed. The presidents of the board of marine underwriters and the merchants' exchange telegraphed to Commander Bartlett, in charge of the hydrographic office at Washington, to-day on the subject.

IT is rare that lightning does so much damage in a month as was done in May. Besides numerous fatal strokes, a petroleum tank was struck in Cleveland, resulting in a loss of $15,000, and the destruction of the Hazard powder works near Denver, is believed to be due to this cause. But the most destructive bolt was that which struck a tank of crude oil at the works of the Atlantic Refining Company, in Philadelphia. It was struck on May 24, at night. The fire, resulting from the stroke, lasted nearly two days and spread over about four acres of ground, resulting in a loss of about $600,000.

MR. JOHN T. HARDING, of Pentwyn, near Monmouth, England, reports in *Symons' Met. Magazine* for April, the following results of spectroscopic weather-forecasting:

1884.	No. of observations.	Verified.	Approx. verified.	Not verified.
January,	31	19	9	3
February,	29	16	5	8
March,	31	22	7	2

Taking the approximate verifications as half-verified, this gives a percentage of 74 verifications in 91 observations. This percentage is not so large as that obtained in this country by sunset observations.

PROF. CUTHBERT P. CONRAD, of Fayetteville, Arkansas, furnishes the following report:

On the evening of February 26, 1884, a phenomenon known locally as "weather lights," was the precursor of a violent snow storm. I have watched these "weather lights" in this locality for four years, and while I have lived in five states east of the Alleghanies, have never witnessed similar phenomena elsewhere. The appearance is that of a rosy red to white light appearing above the horizon, 5°, 10°, and even 30°, and all the way from northeast around to the southwest—sometimes only in the northwest (the most frequent quarter); sometimes first in the northeast, fading out and appearing in the northwest, west, or southwest. These lights invariably precede a change in weather—either rain or snow (*i. e.*, a change invariably follows), but I have not been able to fix upon any definite interval of time.—*Weather-Review.*

IN *Symons' Met. Magazine* for April is a detailed account of the English earthquake of April 22, with two interesting maps, one showing the places where the earthquake was felt, the other, on a larger scale, where damage was done. The shock was felt from Ostend, Boulogne and the Isle of Wight to near Manchester and the mouth of the Humber, covering a region of upwards of 50,000 square miles. Damage was mostly confined to Essex, and the greatest intensity was limited to an area of about nine miles east and west, and about five miles north and south, making an area of 45 square miles, or less than a thousandth of the area over which the shock was felt. In the center of this area, in a thinly populated district of about 25 square miles in extent, scarcely a building escaped. The total damage done is considerable. The shock occurred between $9^h\ 17^m$ and $9^h\ 18^m$ in the morning, was accompanied by sound, and the motion seems to have been propagated from a point immediately below the parish of Peldon, about six miles south of Colchester. The shock took less than two minutes in passing to the extreme points reached by it, distant from the center from 150 to 180 miles, and its velocity of propagation must have been between one and two miles per second. It is not often that so complete a study of an earthquake can be made.

BAROMETRICAL OBSERVATIONS IN BOULDER CANON,

Taken Monday, March 3rd, 1884, by Edward S. Snell, C. E.

NOTE—All distances given below are in feet. "R. R. is the Greely Salt Lake and Pacific."

TIME.	STATION.	Barometric Reading.	Elevation above Boulder.	Ele. above last nam'd sta.	Distance from Boulder	Dist. from last Station	R. R. Grade feet rise per 100 ft.	
							Av'age from Bould'r	Av'age from last Station
9:20	Boulder Depot.	5640	.....	.....	.....	.....	.....	.....
9:25	Toll Gate.....	5750	110	110	4500	4500	2.44	2.44
9:40	Cooper City...	6050	410	300	13700	9200	3.99	3.26
9:55	Langdell.....	6320	680	270	22000	8300	3.09	3.25
10:10	Crisman	6610	970	290	29600	7600	3.29	3.81
10:25	Salina	6900	1260	290	36600	7000	3.44	4.14
11:00	Sugar Loaf....	7200	1560	300	44000	7400	3.50	4.06

The barometer is an aneroid government standard, $4\frac{1}{2}$ in. in circumference, by $2\frac{1}{2}$ thick. It is very delicately constructed, showing a change in pressure from the floor to the table.

WE were indebted to the Hydrographic office for our first notice of the large fields of pumice-stone passed through by the ship "Charlotte Croom." We are indebted for the following details to the chief officer of the ship, Mr. R. Haylor. The pumice-stone was first seen Nov. 6, 1883, in lat. 13 deg. 0 min. south, long. 83 deg. 20 min. east. This was like dust lying on the water and was taken to be fish-spawn until it was brought up and examined. As they proceeded north, the fragments of pumice increased in size until they became as large as a hen's egg. It was last seen in lat. 1 deg. 30 min. south, long. 82 deg. 40 min. east, Nov. 16, on the passage from Algoa Bay to Chittagong. On the return, the pumice was met in lat. 0 deg. 20 min. south, long. 86 deg. 40 min. east, on Feb. 9, 1884. Pieces as large as a man's head were then seen, though it was generally finer, much of it being dust. It lay in streaks, extending as far as the eye could reach. It had evidently been floating for some time, as it was often entirely covered with barnacles. It was very abundant until last seen, which was in lat. 23 deg. 30 min. south, long. 64 deg. 30 min. east, on Feb. 25.

It was sufficiently surprising to learn from Capt. Clarke (see p. 6) that the pumice had got out 1000 miles southwest of Sunda Straits, but we now learn that it had almost reached Rodrigues Island on Feb. 25. If, as is not improbable, the same advancing edge was noted by the *Sea Witch* (Jan. 4) and the *Charlotte Croom* (Feb. 25), it must have advanced in the interval at the rate of 30 miles a day. The surprising amount of material ejected is illustrated by the fact that the *Charlotte Croom* was sixteen days in passing through it, in which time she made a stretch of upwards of 2100 miles.

THE year of 1816 was unusually cold, and the newspapers are interesting themselves in describing it as a year without a summer. The cold was not confined to the United States but was felt in Europe, and the summer of this year was the coldest of the century in Paris. It was also a year notable for sun-spots. Wolf makes it a year of sun-spot maximum, and some of the spots were visible without telescopic aid. Of course the coldness of the season is at once (and was at that time,) attributed to the sun-spots. We find some objections to this explanation for the cold winters of 1776 and 1799 occurred at the time of a minimum of sun-spots. We prefer to attribute this excessive cold to the foundation of the *North American Review*, or to Napoleon's escape from Elba, both of which occurred in 1815. While we think the first a sufficient cause, the well-

known coldness of Napoleon and his sympathy with the elements, lead us to consider the second the effective cause. Napoleon's great undertakings were followed by excessive cold—a fact well-known to historians, though meteorologists seem to have neglected its plain teachings. His career began immediately before the cold winter of 1794–5; his invasion of Egypt was immediately followed by the excessive winter of 1798–9; and we need hardly recall the winter which followed his invasion of Russia. Napoleon himself recognized the sovereignty of temperature. No man was ever cooler on the battlefield than himself, and, on the summit of the Alps, before descending into Italy, he announced in his first proclamation that "famine, cold, and misery are the school of good soldiers." Indeed if his mother had not made undue haste to reach her home, Napoleon would have been born in the open air, and at the moment of his death, Nature developed an energetic depression over St. Helena. Much more might be said to strengthen our position, but we prefer to leave it to the judgment of meteorologists, satisfied that for the coldness of the year of 1816, we have in Napoleon a more efficient cause than in the sun-spots.

SERGEANT FINLEY'S four *study-maps of the tornadoes* of April 1, are now out. There were thirteen tornadic storms distributed as follows: one near Vicksburg, three in northwestern Alabama, one in northern Georgia, one in Central South Carolina, four in Indiana, of which three were along the Ohio river, and three in central Ohio. They occurred, in local time, from 5 to 6:30 p. m. in Indiana, 6 p. m. in Mississippi, from 6 to 7 p. m. in Alabama, from 6:30 to 7 p. m. in Ohio, and about 7 p. m. in South Carolina. The storm-center passed during the day from central Nebraska to south of Sandusky, and, at the time of the tornadoes, was about on the line between Illinois and Indiana, not far south of Lake Michigan. Seven of the tornadoes were not far distant, while the remainder were about six hundred miles away.

The number of persons killed by these tornadoes is estimated at 52; the number wounded, 277; valuation of property destroyed, $780,000.

The trough-like depression southward, which has been a striking feature in the preceding sets of maps, is not notable with this storm-center. We have, however, in this case again the southeast quadrant as their seat, and we have them occurring in a region of nearly uniformly high temperature and unusually high dew-point. To the west the isobars sweep rapidly southward.

It is worthy of note, in this connection, that the other local storms are apt to occur in the southeast quadrant of a storm-area. This is recognized in hail-storms, and by an actual trial we have found it generally true for the thunder-storms east of the Rockies, noted in the March *Weather-Review*. To state it in another way, when any territory was occupied by thunder-storms, the low-center was northwest from it. In but very few cases, perhaps 5 per cent., did we find the low-center located farther than 90° from the northwest. The distance of the centers from the region of thunder-storms was usually great, averaging perhaps 400 or 500 miles.

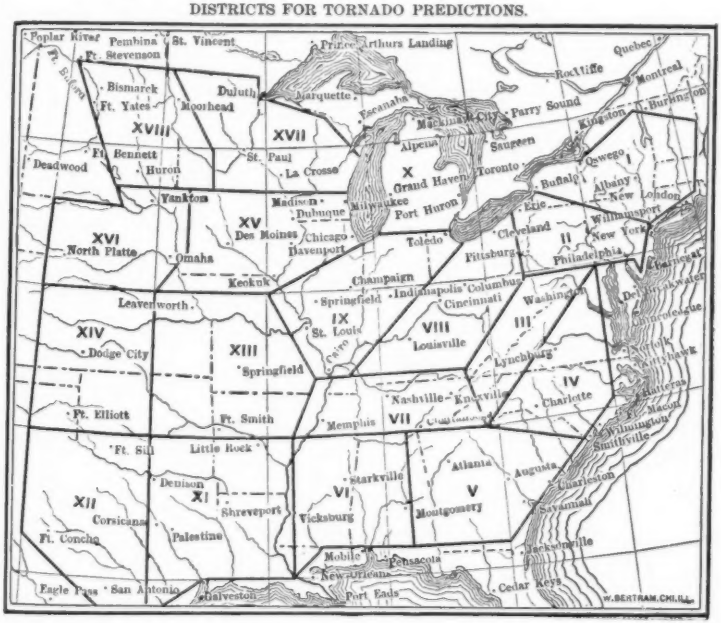
The present line of Sergeant Finley's studies is an extremely promising one, and we begin to hope that we may soon be able to predict the regions in which tornadic storms may be expected. More than this can hardly be expected.

TORNADO PREDICTIONS.

The study of the daily weather maps, for the purpose of determining the conditions favorable for the development of tornadoes, has received special attention during the past few months.

In preparing for the work of making tornado predictions it was

DISTRICTS FOR TORNADO PREDICTIONS.



necessary to ascertain as nearly as possible the limits of that portion of the United States within which tornadoes were likely to occur. Within this territory there are tornado belts or limited regions where tornadoes are of frequent occurrence, the limits of which were determined by the geographical distribution of tornadoes as taken from the records of 90 years. Each district is sub-divided by imaginary lines into four equal parts and predictions are made either for the entire district or for any one or more of these parts.

Tornadoes being remarkably local disturbances, the area for which predictions are made on any one day should be as limited as possible.

The accompanying map shows the territory for which predictions have been made and the locations and adopted numbers of the various tornado districts.

With additional data to complete the tornado records of past years it is believed that hereafter the above districts may be located more advantageously. Regular tornado predictions were commenced experimentally on the 10th of March, 1884, and during the remainder of that month were made twice daily at intervals of eight hours. The first prediction was made from the morning (7 A. M. Washington time) weather map and covered the eight hours up to 3 P. M. The second prediction was made from the afternoon (3 P. M. Washington time) weather map and covered the eight hours up to 11 P. M.

During April the same plan was pursued.

For the month of May the first prediction was made from the morning weather map and covered the sixteen hours up to 11 P. M. The second prediction was made from the afternoon map and covered the eight hours up to 11 P. M. The eight hour predictions for May were made in order to show the comparative value for study of the morning and afternoon weather maps. The number and character of predictions and the percentages of verifications for the above months are given in the accompanying tables.

TABLE NO. I.

Tornado Predictions and Verifications.

Month.	Predictions for	Total number.	Number of predictions "favorable for tornadoes."	Fully verified.	Number of predictions "unfavorable for tornadoes."	Fully verified.	Total number made.	Total number fully verified.
March	8 hours	771	43	6	728	731	771	737
April	8 hours	934	25	11	909	906	934	917
May	8 hours	558	10	8	548	542	558	550
May	16 hours	549	22	3	518	511	549	514

TABLE NO. II.

Percentage of Tornado Predictions.

DISTRICTS.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	GENERAL AVERAGE PERCENTAGE.
March..... Eight hour predictions.	100.00	98.86	95.46	88.53	95.92	92.56	88.53	87.86	89.10	100.00	93.30	100.00	91.32	100.00	99.43	100.00	100.00	100.00	95.61
April..... Eight hour predictions.	100.00	100.00	100.00	95.28	96.22	95.28	100.00	98.11	99.04	98.11	99.01	100.00	94.07	100.00	98.08	100.00	100.00	100.00	98.51
May..... Eight hour predictions.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	96.77	96.77	96.77	100.00	100.00	95.16	96.77	96.77	96.77	100.00	100.00	98.65
May..... Sixteen hour predictions.	100.00	100.00	100.00	95.16	98.39	98.39	96.77	90.32	88.71	96.77	93.10	100.00	82.50	100.00	97.67	100.00	100.00	100.00	96.54

NOTE.—As shown in table No. 1 the number of predictions for any month is determined by multiplying the whole number of tornado districts by the product of the number of days in a month and the number of times of daily predictions for that month. From this result is subtracted the number of blanks, viz., the number of times when predictions could not be made for one or more districts, owing to the absence of reports. In tables Nos. I and II the results of the 7 A. M. and 3 P. M. predictions are combined for the months of March and April, while for the month of May they are considered separately, for reasons before given.

By an examination of table No. I. it will be seen that the predictions are of a dualistic character; (1) those favorable for tornadoes, (2) those unfavorable for tornadoes. Both are positive predictions, and it requires as much, and often more, study to say that no tornadoes will occur as to make the prediction that conditions are favorable for their development.

From the 1st of March to the 1st of November the daily weather maps require close and constant study, and in this connection it is hardly necessary to say that the atmospheric conditions incident to the formation of local disturbances, such as tornadoes, hail storms and hurricanes, are not as readily discovered as in the case of more general changes.

It is important to state that the test of complete verification of any prediction was determined by the appearance or non-appearance of the characteristic funnel shaped cloud in the region for which the prediction was made. In no instance where it was predicted that conditions were favorable for the development of tornadoes did violent storms fail to occur, either hail, hurricanes or tornadoes. In many cases the winds were very destructive to life and property, more particularly the latter, but the predictions were not counted as successful tornado predictions unless the funnel-shaped cloud was actually reported as a feature of the storm. No prediction of conditions favorable to tornadoes was counted a success unless the tornado's path was clearly within the region or district for which the prediction was made and occurred within the eight or sixteen hours specified.

The reports from all districts are not yet complete, and from many localities none will be received except, perhaps, at a very late day. The number of tornado reporting stations, now over 800, is too few to properly cover the territory for which predictions are made and from which regular reports should be received.

Tornadoes are extremely local disturbances; in many cases the funnel-shaped cloud, although perfectly formed, does not reach the earth, but remains at a considerable elevation like a captive balloon, being attended by hail and gusts of wind. In such cases the damage done by the wind is often not attributed to a tornado, although the latter really exists.

JNO. P. FINLEY,
Sgt. Signal Corps, U. S. A.

THE SLING-PSYCHROMETER.*

Every practical meteorologist knows how seldom correct and altogether reliable observations in temperature are met with However easy the reading of a good thermometer may appear, the difficulty is in placing it so as to answer in all cases.

Formerly the thermometer was placed against the wall of a house in the free air, a method which is still employed by many stations of the Royal Prussian Meteorological Central office. The thermometer was thus unprotected from reflection, or even rain, and there was no account taken as to the height from the ground and the nature of the soil where it was placed. Recently, however, and mainly through the labors of Mr. Wild, a thermometer house or box has been contrived in which the thermometer is placed. It is more fully exposed to the currents of air and protected alike from radiation and rain.

There is do doubt that, if this manner of placing the thermometer is the best one known, the other methods do not permit a strict comparison in respect to observations made. A careful examination of observations taken from the large thermometers in one of Mr. Wild's houses in the meteorological observatory at Magdeburg has proved, however, that this method is faulty and unreliable in many respects. There is no doubt that a thermometer which is placed in the free air will indicate the changes of temperature quicker than one that is protected.

The thermometer in Mr. Wild's house is considerably behind in its indications whenever, after sunrise, the temperature of the air suddenly rises or, after sunset, falls, or when there is a sudden change from sunshine to cloudy weather. This is especially the case when there is a calm at the same time. It takes considerable time for the wooden enclosure and the stagnant air in it to become warm or cool, as the case may be. But we do not want to measure the temperature of a certain amount of air enclosed in a house, but that of all air, as it is made by the action of direct and radiated rays. There is one other great objection to Mr. Wild's house; *i. e.*, its comparatively high price, which will always prevent its coming into general use. But uniformity of method in placing the thermometer would be of the highest importance in making a strict comparison of observations of temperature possible.

How and by what means can such be obtained? The question is an eminently practical one for the reorganization of the meteorological service in Prussia. By an entire remodelling of the present system uniformity of methods can be reached much easier than by a change of the old one.

The placing of a thermometer must be done according to the following scientific requirements:

1. The thermometer must indicate the actual temperature of the air as nearly as possible, and be able to indicate any change in it as quickly as possible.
2. The thermometer must be protected from radiation.
3. The thermometer must be protected from rain.
4. The observation of temperature must be independent of all local influences.
5. The method must require apparatus so cheap that the cost will not prevent its being used in stations of lower rank.

Of all methods hitherto in use there is not one which perfectly fulfills these requirements. It is for this reason that I have made experiments and comparisons for several months with the sling-thermometer, which has been but little used in Germany. I think that this is the fittest instrument for general use.

*Translated from the Austrian *Zeitschrift* for April, 1884. The centigrade thermometer scale is employed.

1. The sling-thermometer is sensitive to a high degree, since by quick motion it is brought in contact with a greater amount of air. The slow effect of a calm is thus done away with.

2. Radiation has almost no influence at all upon it, if a shady place, covered with vegetation, is chosen. Even in the hot sun its influence is but slight, not exceeding three to five tenths of a degree.

3. The sling-thermometer can easily be protected from rain by using a large umbrella at the time of observation.

4. The observer can always select a shady place for making observations. Indeed, it is not our aim to ascertain the temperature of a yard, perhaps small and unapproachable by any air-current, but that of a large place. For this reason any change of temperature can be more nearly ascertained by changing the place of observation within narrow limits than by an accumulation of errors, which must be a necessary consequence, whenever a thermometer is placed in a fixed position.

5. The method is the cheapest imaginable, since there is no need of any apparatus whatever for setting up the thermometer.

But whatever may be said with respect to observations of temperature is true in even a greater measure of the determinations of the moisture in the air. The psychrometer which is now generally used for the purpose of measuring the humidity of the air is the most unreliable of all meteorological instruments. Whatever is required of a thermometer applies to this instrument; but there is special need in this case to bring the instrument in contact with as much air as possible. On opening the psychrometer-box in summer when there is a calm, a sudden falling of the moist thermometer, which is supplied with a wick having one end in water, is noticed immediately after the air inside, which is filled with vapor from the vessel and the covering of the thermometer-bulb, is renewed. It is owing to this fact that ventilation-wings have been so generally introduced in Italy. But these are very costly and require, moreover, all the expensive contrivances for protection of the thermometer. According to Mr. Wild's statement, a psychrometer, accurately placed, would indicate the relative moisture correctly within 3%, even in summer. But the difficulty and uncertainty of the psychrometer results is not so apparent in summer as in winter. The air in summer being warmer than in winter, can more easily be put into motion, as in the latter case, the lower strata, filled with heavy air are often stagnating for days under the influence of a maximum pressure. This is because the oblique rays of the sun are frequently intercepted by fog, and do not exert so considerable an influence upon the lower strata of the atmosphere. In summer the moist thermometer is placed permanently at its lowest mark by means of the moist wick; but in winter, an indefinite time elapses before it reaches its minimum position, after it has been warmed above 0°. Thus the psychrometer is much more reliable in summer than in winter. To this must be added the important fact that at low temperatures, an uncertainty in the thermometer indications produces a greater uncertainty in the estimated humidity. According to Jelineh's tables, if the reading of the thermometers be 20° and 19°.5 respectively, the relative humidity is 95%; but an uncertainty of 0°.1 in the moist thermometer, makes its reading 19°.6, and the relative humidity 96%; if however, the reading give 20° and 20°.5, the tables give 68%, and an uncertainty of 0°.1 in the moist thermometer may make 20°.4, the correct reading giving 74% as the relative humidity. Thus an error of 0°.1 in the moist thermometer at a temperature of 20° introduces an error of 1%, while the same error at 20° results in an error of 6%. It is here then that the psychrometer introduces considerable errors. Now every practical observer knows what trouble is necessary to

obtain a correct reading of the psychrometer in winter when the temperature is low. At a temperature of 20°, and when the air is calm, it requires at least a full hour to obtain the true lowest degree of the moist thermometer. Any method by which this amount of time can be lessened, must necessarily prove of great value in improving the observations.

Now this is done to a great degree by the sling-psychrometer. Although I have experimented but little at low temperatures, yet I have, on the Brocken for instance, at a temperature of 8° frequently brought my moist thermometer on the sling-psychrometer to its lowest point in form 1, to 1½ minutes, while the protected and fixed moist thermometer could not be brought to the same point before the lapse of from 10 to 12 minutes. I am convinced by my frequent excursions to the Brocken, that here, as at all high stations, exact observations for temperature and moisture can be made only by means of the sling-psychrometer. For a psychrometer placed outside the prevailing direction of the wind, yet made to come in contact sufficiently with the change of air, would within one hour be so fully covered with hoar frost that it soon assumed the form of two icicles of 5° each, which, a few hours later, became one; moreover, the chinks of the psychrometer case would fill up, so that, in place of the psychrometer, there was a solid block of ice. Observations with such instruments, are of course valueless on account of the impossibility of moistening the thermometers. In such cases, however, the sling-psychrometer would show in a short time considerable differences between the thermometers, although the summit of the Brocken was entirely covered with clouds; however, the thermometer must not be taken directly from a warm room, but from one heated but little above 0°. During the short time of my observation, I protected the instrument from hoar-frost by means of an umbrella held against the wind; moreover, I chose the lee-side of the house which is less exposed to hoar-frost. In winter it often happens upon the Brocken that a fixed thermometer is altogether buried by the snow and then cannot be reached by the observer. With the sling-psychrometer, the observer is not confined to any definite place, but chooses it at pleasure.

I do not wish to settle the theoretical question as to the judgment of the value of results obtained by means of the sling-psychrometer before I have made a series of comparisons by means of the condensation-hygrometer of Alluard.

Very important for such experiments is the work of Sworykin (see Repertorium for Meteorology, vol. vii, No. 8), who has made careful comparisons with the ventilated Italian psychrometer, and the volume and condensation hygrometer. He concludes that a slight volicity of air, say below 3^{m} a second, exerts a considerable influence upon the psychrometric results; that this influence, however, decreases at a rapid rate as the velocity of the air increases, and finally becomes constant.

The psychrometer will describe a circumference of 3^{m} in one revolution if the string of the sling-psychrometer, is of such a length, that the vessels of the thermometer are at a distance of 50^{cm} from the center. Now it is easy to make the instrument revolve 180 times per minute, in which case the thermometers receive a velocity of air of more than 9^{m} per second, which would lessen considerably the liability to error according to Sworykin. It is undoubtedly more rational to have a certain medium velocity of air strike the psychrometer, which can easily be brought about by a little practice in swinging, than to make observations with a psychrometer which is exposed to changes in the velocity of the atmosphere. Of course there would be needed for this purpose the acceptance of a new constant, and consequently a change in the computation of the psychrometer-tables, which are now based upon but slight motion of the air. The advan-

tages, however, to be derived from the sling-psychrometer would far outweigh such temporary difficulties.

My own experiments were made in a very large room, unexposed to changes of temperature. There was but a slight wind outside which did not strike the windows. The wooden blinds were let down to prevent any cooling effect from the direction of the windows; the temperature outside was about the same as that of the room in which I experimented. The instrument was hung upon a hanging lamp in the middle of the room, and 1.5^{m} from the floor; hereupon it was moistened with water of nearly the same temperature as that of the room, and the observations were taken in perfect quietness, or with slight motion, or slow, or quick rotation. The results were in all cases the same as may be seen from the annexed table:

July 26th, 1883, temperature of atmosphere at 2 p. m. 19.0°, 3 p. m. 18.8°

Motionless.			Motion of Pendulum.			Swinging with vel. of 3^{m} per Sec.			Swinging with a vel. of 6^{m} per Sec.		
dry.	moist.	re. humidity.	dry.	moist.	rel. humidity.	dry.	moist.	rel. humidity.	dry.	moist.	rel. humidity.
18.6	15.0	66%	18.7	14.3	59%	18.7	14.1	57%	18.7	14.0	57%
18.7	15.0	65	18.8	14.6	60	18.8	14.3	58	18.8	14.2	57
18.7	15.0	65	18.8	14.6	60	18.8	14.3	58	18.8	14.2	57
18.8	15.2	66	18.9	14.8	61	18.9	14.5	59	18.9	14.2	57

From this little table it will be seen: 1. That the indications of the dry thermometer are lowered in consequence of evaporation on the moist thermometer near by (at a distance of 2 ^{cm}), if the psychrometer is motionless and there is a perfect calm. In this case the constant is 0°.1: 2. That a slight motion of the atmosphere is sufficient to lower the indications of the relative humidity, from 5 to 7%, even if the thermometer moves in the same bulk of air as it does in the pendulum motion; 3. That a motion of 3^{m} per second effects a lowering of 2 to 3% in the indications of relative humidity. 4. But that motion of 6^{m} per second, effects a change of only 0—2%; 5. That the indications of the dry thermometer are influenced but little by the velocity.

The time required for the moist thermometer to reach its lowest reading as ascertained from the average of ten experiments, amounted to 225 sec. when it was motionless, 115 sec. when it swung as a pendulum, 40 sec. when swung with a vel. of 3^{m} per sec., and 25 sec. when the vel. was 6^{m} per sec. From this it follows that the time required to reach the lowest reading of a sling-psychrometer with moderate velocity requires but $\frac{1}{3}$ the time that an instrument does which is hung up where there is no motion of air.

July 30, 1883.

Time.	Wild's.		Sling-Psychrometer.		Difference.		Vel. of air in meters per sec.	Appearance of Sky.
	dry.	moist.	dry.	moist.	dry.	moist.		
11 a. m...	19.4	15.0	19.0	14.2	0.4	0.8	4.2	Sunshine for 13 min. before.
12 noon..	21.3	15.9	20.7	14.8	0.6	1.1	3.1	Unbroken sunshine.
1 p. m....	21.2	15.8	20.5	14.4	0.7	1.4	2.2	" "
2 p. m....	22.3	16.2	21.0	15.0	1.3	1.2	1.4	" "
3 p. m....	22.8	16.2	22.2	15.1	0.6	1.1	2.2	Sun disappeared at 3.04 p. m.
4 p. m....	22.0	16.5	21.2	15.3	0.8	1.2	4.7	Cloudy. Shower at 4.45 p. m.
5 p. m....	17.5	14.9	16.0	14.0	1.5	0.9	0.9	Cloudy.
6 p. m....	17.8	15.0	17.5	14.5	0 3	0.5	0.5	Occasional sunshine.
7 p. m....	17.8	15.2	17.1	14.3	0.7	0.9	1.9	Cloudy.
8 p. m....	17.1	14.9	16.2	14.0	0.9	0.9	3.8	3-10 clouded.

The foregoing table contains ten results of hourly observations on the thermometer in Mr. Wild's box, and on the sling-psychrometers which were placed in the shade above the sward in the immediate neighborhood. Mr. Wild's box is double, the outer case is 2.37^m long, of the same width, and 3.50^m high, while the inner case is 1.35^m long and wide, and 3.10^m high. The space between the two cases is 0.40^m. The blinds, which are single in the outer, and double on the inner case, reach to within 1.80^m of the ground. The inner case has a double roof, and a ventilation tube, the outer has a single roof of zinc, both sloping slightly toward the south, while toward the north both cases are open. The thermometers are in a zinc box, which by means of alternate openings in the double bottom cuts off all effect of radiation without hindering ventilation. The house is placed on a grass-plot about 11,000 sq. meters in area.

Besides the comparisons are noted the state of the wind, the proportional amount of cloudiness, and the amount of sunshine during the day, recorded by the Stokes-Campbell Sunshine Autograph, which was placed near the thermometer case.

In obtaining these tables I proceeded as follows: After a cloudy morning, the sun came out at 10.47, the temperature began to rise, the wind was light; in the case the dry thermometer stood 0°.4, the moist one 0°.8 higher than on the sling-psychrometer quite near by; there were no reflecting objects near by, as the sward would reflect no sensible amount of heat. Within an hour the dry thermometer in the case rose 1°.9, but the moist only 0°.9, on the sling-psychrometer only 1°.7 and 0°.6, while the sun was constantly shining, and the wind became lighter. This radiation had exerted a greater influence on the enclosed than upon the sling-thermometer, which fact is to be accounted for by lighter wind, and the heating of the case. At 1 p. m,, both the dry and the moist thermometers had fallen one degree; on the sling-psychrometer, the dry had fallen two degrees, and the moist, four degrees, while the wind became lighter in the continual sunshine. The increasing difference of the moist thermometers may have its origin in the imperfect removal of the vapor. At 2 p. m. in full sunlight, the dry thermometer in the box had risen 1°.1, the moist 0°.4; but on the sling-psychrometer only 0°.5 and 0°.6, and the wind had become still lighter. The difference of the inner and outer thermometers had increased to 1°.3 and 1°2, which, likewise, might lead one to suppose that there was radiation from the wooden walls and imperfect ventilation. At 3 p. m. the sun was still shining, it had grown more cloudy, as a stratocumulus cloud had come up from the southwest. In the box the temperature of the dry thermometer had risen 0°.5, while the moist remained unchanged; outside the box the dry thermometer stood 0°.8, and the moist 0°.1 higher than an hour before. By this means the difference between the inner and outer dry thermometers was diminished from 1°.3 to 0°.6, but the difference of the moist thermometer had remained nearly unchanged. It is interesting to notice how quickly the relative humidity on the sling-psychrometer had diminished; for while in the forenoon it amounted to only 2 or 3°, it had now fallen about 6%; but there was a difference of only 3% in the box, since in consequence of the lightness of the wind the box was poorly ventilated. Such quick changes of the relative moisture can be noticed very often shortly before a heavy rain. Shortly after 3 p. m. the sun was hidden by dense clouds, and the wind became a little stronger; at 4 p. m. we find the dry thermometer in the case 0°.8, the moist 0°.3, the outer dry 1°.0, and the moist 0°.2 lower than before; the trifling excess of temperature in the case was owing to the radiation of heat from the case; in the meantime, the stronger wind had increased the relative moisture pretty equally, in the case 7°, and in the

free air 8°. At 4.45 a short but heavy shower cooled the air considerably—in the case 4°.5, in the free air 5°.2; the slighter cooling of the air in the case was, no doubt, due to the influence of the heat remaining in the walls; the relative moisture, in spite of the slight wind, now rose in the free air from 51° to 79°, in the case from 54° to 74°. Therefore, the air in the case was drier than that outside; for in the case the relative moisture had risen 20°, but outside 28°. This seems to be a proof of the assertion that the case causes a lagging in the changes which does not exist in the use of the sling-psychrometer. It must be remarked especially that the sling-psychrometer was not wet, as the rain was over when the observation was taken. At 6 p. m. the sky was still cloudy, with a light wind; yet, at times, the sun appeared. Within the case, the dry thermometer had risen 0°.3, the moist 0°.1; outside the dry had risen 1°.5, the moist 0.5. Here too, the lagging of the instruments in the case is considerable as compared to the sling-instruments. There was a decrease of the relative humidity in the case of 2%, outside of 9%. At sunset the sky was again cloudy, the wind that was from west, southwest to southeast became somewhat stronger. At 7 p. m. the dry thermometer in the case was unchanged, the moist had risen 0°.2; on the sling-instrument, however, the dry thermometer had fallen 0°.4, the moist 0.2. It cannot be supposed that this falling was due to the stronger radiation upon the sling-psychrometers since the sky was entirely clouded. The relative moisture had become nearly equalized through this opposite change in the thermometer since it amounted to 74% in the case, and outside to 72%. At 8 o'clock, when it cleared up, and the wind became somewhat stronger, the thermometers in the case were 0°.7, and 0°.3; on the sling-psychrometer 0°.9, and 0°.3 lower than at 7 o'clock; the relative moisture in the box had risen to 78%, and outside to 77%.

Time.	Rel. humidity in Wild's case.	Rel. humidity Sling-psychrometer.	Difference.
11 a. m.	60%	56%	+4%
12 noon	54	50	+4
1 p. m.	54	47	+7
2 p. m.	50	49	+1
3 p. m.	47	43	+4
4 p. m.	54	51	+3
5 p. m.	74	79	−5
6 p. m.	72	70	+2
7 p. m.	74	72	+2
8 p. m.	78	77	+1

For the sake of completeness we give the relative humidity of the case and sling-psychrometers, from which it will be seen that the same remained constantly a few per cent. higher in the case than in the sling-psychrometer, except immediately after the shower, when it was 5% lower, a fact which may be taken as a proof of the greater sensitiveness of the latter as compared to the reading of fixed and well protected instruments. The above table is deliberately chosen as a key to further investigations on the suddenly changing conditions of the clouds, wind and rain.

I may make further communications concerning the ease with which a sling-psychrometer may be set up, especially in winter, as well as the result of careful comparison with the condensation hygrometer. The above preliminary description does not claim the title of a strictly physical investigation of the sling-psychrometer, but I hope it may lead to further investigations.

If the defects of this method, after applying the precautions pointed out, should prove so trifling that they may be neglected with no appreciable error, then this

1877) the maximum mean should enter; but that since that time there has been a simplication of the instruments will render it possible to obtain observations of temperature and moisture which will be useful and easily compared..

Fuess, of Berlin, has constructed, according to my directions, a sling-psychrometer of a very convenient form. It consists of two small rod-thermometers, with scale divided to half degrees, and a small cylindrical vessel 5^{mm} by 50^{mm}. On the moist thermometer there is a glass bulb for the fastening of the covering. These are mounted on a wooden frame with a fork-shaped slit through which the silken cord is drawn. The box is of zinc, and contains a small vessel of water in the lid for moistening the wet thermometer on a journey. Fuess furnishes the same complete for 18 marks.

DR. R. ASSMANN.

RECENT PHYSICAL PHENOMENA.

(By M. FAYE.*)

It is a well known fact that for some time numerous exceptional phenomena have occurred, such as the frightful volcanic explosion of Krakatoa, immense waves which have passed through the sea or the atmosphere making the entire circuit of the globe, strange lights and colors in the sky, a January which resembles April for temperature, strange oscillations in the frequency of the sun spots, of which it seemed impossible to produce the maximum, derangements not less singular in the ordinary progress of the magnetic needle. That which strikes me more than anything else is that all these facts have been predicted or explained by cosmic influences; it is to Jupiter, to Mars, to the swarms of shooting stars that these phenomena are referred, and as the movements of these stars are well known and can be well calculated for a long time in advance, it seems easy, hereafter, to forsee for a long term, geological, meteorological, magnetic and even solar phenomena.

I believe nevertheless that this ought not to prevent us from recording and studying them as usual. That is why I continue to communicate to the Academy what I have recently collected.

In that which regards the exceptional temperature of this winter, I wish to call attention to the fact, that according to the *Times* of January 19, there has been in South America a summer temperature which is quite extraordinary. It is rarely, at Buenos Ayres, that in summer (December and January) the temperature surpasses 92° F. in the shade; it has been this year, 101° F.

The *Buenos Ayres Standard* supposes that the unprecedented temperature is due to the five little comets that our celebrated correspondent, M. Gould, is observ ing, it is said, at Cordoba, capitol of the Argentine Republic. You will see by that that the cosmic influences are not less in vogue in the Southern Hemisphere than in the Northern. It is true that the temperatnre of our month of January does not accord very well with a very recent prediction, which announced a January particulary cold and vigorous; but with the shooting stars there are always ways of arranging things. If, then, we prove a farther general elevation of temperature at this epoch, as the preceeding observation would have us believe, we have only to suppose that our atmosphere has been invaded by a swarm of meteors coming to strike the earth with a velocity of 60 to 70^{km} per second, and to

*Translated from *Contes rendus* No. 4.

the first time that such a thing has been seen. Sunday, Sept. 2, the rising sun was a beautiful blue; its light was soft; one would have said, that of the moon. Not a cloud in the sky. At midday the sun was more brilliant, but still bluish. At sunset, the sun could be inspeced; around its disk numerous horizontal rays could be seen, of a dark blue upon a back-ground of light blue. In proportion as the sun disappeared, the blue color became grayish, and after the sun had completely disappeared, a splendid flame colored aureole was seen. This lasted until 8 o'clock. The clouds presented the various hues of the iris, and produced a grandiose spectacle in that part of the sky. Analogous phenomena were observed at Puerto Cabello.

THE EPOCH OF THE RECENT MAXIMUM OF SUN SPOTS.

(From the Data of M. R. Wolf, of Zurich. By M. Faye.*)

M. R. Wolf has asked me to communicate to the Academy a note concerning the actual course of the solar spots, and desires me to express my opinion on the subject. Here is, in the first place, the letter of my learned correspondent:

"I have the honor of addressing to you—I think it will interest you, you and the Academy—the result of my solar statistics for the past year, and I join to them those of the preceding year:—

	1882.		1883.	
	Relative number.	Days without spots.	Relative number.	Days without spots.
January	41.8	0	59.4	0
February	68.8	0	45.5	1
March	66.7	0	43.3	1
April	97.0	0	83.0	0
May	63.9	0	30.1	1
June	45.5	0	77.9	0
July	45.9	0	77.3	0
August	42.7	0	46.0	0
September	59.4	0	50.6	1
October	53.9	0	83.1	0
November	84.9	0	82.6	0
December	40.5	0	75.3	0
Mean	59.3	0	62.8	4

It results from this that the mean of the relative numbers is a little higher in 1883, but that the greatest monthly mean belongs to 1882, and that the number of days without spots (with the normal instrument) was four in 1883, opposed to zero in 1882.

It may be seen that after the minimum of 1878–79 the two lines ascend quite regularly until April, 1882; that is, up to the moment that (see my work of

*Translated from *Comptes rendus* No. 4.

calculate the quantity of heat which will be engendered thus in our atmosphere by the shock of a few *kilogrammes* of this matter in a state of cometary diffusion.

Here, in the second place, is an observation of a blue sun, in Venezuela, which was communicated to me by M. Haas. It is, says the *Review of Corupono*, whole series of rises and falls (one would say they were caused by interferences), and that there are no means, up to this time of determining certainly, the moment that the phenomenon has passed, or will pass, the maximum, and *it is very interesting that the magnetic variations follow the spots in all their irregularities.* It is evident that it is exactly these common irregularities which furnish incontestable evidence of the intimate relation between the true phenomena, and it may be presumed (as I have said in No. 60 of the *Mittheilungen*, which I recently sent to you and the academy) that in a few years, when this abnormal period is terminated, great progress will be made in the theory of these complicated and curious phenomena. I should like to live till that time, and succeed in crowning, then, my work of from thirty to forty years."

According to the annual means of the relative numbers for the frequency of the spots, 59.3 in 1882 and 62.8 in 1883, it seems at first that the maximum should be reported in 1883, and, as we see, M. Wolf himself is in doubt as to his position; evidently it disquiets and preoccupies him.

Notwithstanding, the figure 97, in April, 1882, is so large that it seems to justify considering it as the true maximum. This is what results by grouping the numbers differently; not by years, but by half years. We find then for the results:

1882—First half year	424
1882—Second half year	327
1883—First half year	339
1883—Second half year	415

It is a question, then, of a maximum in April, 1882, followed by undulations presenting two maxima in 1883, of 83.0 and 83.1, quite inferior to that of April, 1882. It is what may easily happen in the progress of a periodic phenomenon which passes rapidly, and without fluctuation, from a minimum to the following maximum, but which passes slowly, by a series of secondary oscillations, from the maximum to the following minimum. This is, in effect, the well known progress of solar spots.

What confirms this opinion is the other side of the phenomenon. Schwabe discovered the periodicity, not in counting the spots, but in counting the number of days when the sun showed no spots. At the epoch of a maximum there are no days without spots. From that on, there appear here and there days without spots, but in very small number. At the minimum, on the contrary, it often happens that the solar disk is entirely free from spots.

Now, in 1882, from one end to the other of the year, there was not a single day without spots. The following year, in 1883, they were not visible during four different days. It is an evident indication of decreasing energy. Probably the number of days without spots will go on increasing a little in 1884, and then grow rapidly in 1885, in 1886, in 1887, and so on until the epoch of the minimum. Is is not a question here, then, of a phenomenon exceptional in the history of solar activity. Besides we will soon know what to believe upon this point.

As to the progress of the magnetic needle, M. R. Wolf affirms that it follows with fidelity that of the spots, even at the epoch when the maximum does not seem to him to be clearly defined. If it is like this for the whole earth, it will be a truly decisive argument in favor of the opinion that the diurnal oscillations of the compass are regulated by the frequency of the sun spots. We may not comprehend, it is true, how such a dependence can exist between these two orders of

phenomena, but we are not authorized to deny that which we do not understand, by the fact alone that the thing is incomprehensible. However, we may ask ourselves if the fact is quite certain. As for me I have doubts of it, and here are some of my reasons:

In the first place, there is a striking contradiction between the conclusions of the astronomers at Kew, who have demonstrated that the phases of motion of the compass, toward 1850, followed those of the spots at a distance of five months, and assertions of other astronomers, who have thought, on the contrary, to have proved quite recently that the influence of spots upon terrestrial magnetism is immediate.

Now, see how this contradiction may have arisen. Suppose that to-day there is a simultaneity, purely accidental, between these two phenomena, and that there is between their periods a difference of nearly a month, that is to say, of $\frac{1}{10}$ of their duration. At the epoch of the observations of Carrington and at Kew, the maxima of the spots should have advanced from three to four months beyond those of the compass, and one hundred years ago, at the epoch of the capital observations instituted by Cassini at the Paris Observatory, this advance was from eleven months to a year. Now that is what really happened. It suffices to assure ourselves of it, to cast a glance upon the curves of the two phenomena, about 1787. As to the coincidences of detail between these curves at our epoch, I do not attach a decided importance, because the diurnal oscillations of the needle are submitted to all sorts of influences, purely terrestrial, which it would be exceedingly difficult to deduct, in order to demonstrate clearly their supposed concordance with the sunspots.

It is none the less true that if I am wrong in doubting this concordance, if it really exists, as M. Wolf, who is so great an authority in these matters, believes, it will be the most astonishing problem of actual science.

THE CAUSES:

1st—Of the Production of Atmospheric Electricity in General; 2nd—In Storms; 3d—In Heat Lightning.

(Note by M. G. Le Goarant de Tromelin, presented to the French Academy by M. Faye.*)

1. In searching for the forces in nature capable of producing electricity, I have been led to admit in the first rank the friction of the air, humid or dry, upon the surface of land or of water.

Everybody knows Armstrong's hydro-electric machine. We know that when the steam issues from the heater, the latter remains negatively charged, while the vapor is positively charged. This machine includes a box filled with water to cool the escape tubes. The steam before reaching the exhaust pipes experiences thus the commencement of condensation, and issues mixed with air vesicles. It is a necessary condition.

According to the experiments of Faraday, the passage of dry vapor or of a current of dry air does not free electricity, while a current of humid air gives the same result as Armstrong's machine, but to a less degree.

It is true that Spring found, on the contrary, that the friction of dry air upon a ball of copper gives a little electricity; but in an incomparably less quantity than in the experiment of Faraday. On the other hand numerous experiments

* Translated from *Comptes rendus*, No. 4.

have proved that the evaporation alone of water, even acidulated, does not produce electricity.

But in the evaporation produced by the wind, there is also friction. It is in this last mechanical work that the looked for source resides.

The wind in skimming the surface of the water carries watery particles from the crest of the waves, which play here the part of the comb of Armstrong's machine. The roughness of the soil plays the same part, when a damp wind passes over it.

These molecules of water remain electrified and ascend into the atmosphere to form clouds, and as electricity lies at the surface of bodies, it tends to spread over the most elevated atmospheric surfaces, and I think with M. Faye, that the cirri must retain a great portion of this electricity.

Is there not a striking analogy between these laboratory experiments mentioned above, and the immense operations of the natural forces?

2. This granted, we can conceive that a cloud will be electrified if formed under the conditions above mentioned. (It will not be the same as a cloud which is formed by simple vapor rising in the morning into the atmosphere.)

But in order that lightning be produced, there must be a discharge between the cloud and another point (earth or cloud) such that the difference of potential between the point and the cloud, existing at the moment considered, be sufficient to produce the lightning in question.

Now the distance at which the spark strikes depends on the electric pressure and on the mechanical resistance that the medium opposes to the discharge. This pressure varies with the square of the potential of the cloud, its form, its surface, the charge of the cloud and its distance from the point specified.

Now, the potential energy of a cloud depends upon its form, its surface and its temperature. When the primitively electrified cloud experiences a transformation of any kind, condensation, congelation of the aqueous vesicles, etc., it absorbs a certain quantity of energy, which must be found again under the form of an augmentation of potential energy.

This consequence results from the principle of the conservation of energy, and from the principle of M. Carnot, of which M. Lippmann has taken such a remarkable advantage.

If, then, we suppose that the charge of electricity of a cloud remains constant during a certain time, any condensation or decrease of temperature will augment the potential of its mass.

When a storm bursts, it is rarely without electric manifestations. The abundant condensation, which may be remarked, becomes the cause of the augmentation of the potential of the storm mass, and when this potential is sufficient there is a discharge in the form of lightning. Besides, the continual renewal of the charge indicates that the cause resides in the storm phenomenon itself.

3d. The air being dielectric, the vapor becomes the natural reservoir of electricity. Suppose a mass of vapor of water electrified in suspension in the atmosphere. In the evening when the sun disappears there will be a cooling in the cloudy mass; for the reasons given above, its potential will be augmented.

Now if the potential reaches a certain figure, the vesicles, considered separately, could not retain their charge; that is to say, it will escape into the atmosphere in the form of silent discharges. Thus we may calculate that at the ordinary pressure a small sphere of $\frac{6}{10}$ of a millimeter can not retain electricity at the potential which we obtain with our good laboratory apparatus.

Because of the smallness of the radii of these vesicles, it may be seen that a cloud cannot retain a charge at a potential surpassing a certain figure.

Such is the manner in which are produced the phenomena known under the name of heat lightning. As, for different observers, these flashes appear at the horizon, it is logical to think that they are produced at the zenith, and that they are not the reflection from the lightning of distant storms. It is a similar phenomenon which transpires when a navigator sees a band of mist continually at the horizon, while the sky above his head is clear. It is only a difference in thickness of the layers traversed by the visual rays.

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REVIEWS.

ATMOSPHERIC UP-POURS.

Whirlwinds, Cyclones and Tornadoes. By WILLIAM MORRIS DAVIS, Instructor in Harvard College. Boston; Lee and Shepard; 1884; 12 mo; 90 pp.

The title page of this book is headed "*The Science Series,*" and the book is a reprint of the articles of Mr. Davis in the journal *Science* of some months ago. The ideas of the essay were first used in a course of lectures at the Lowell Institute in Boston in January 1883, and the present reprint is but slightly altered from the original form in *Science.*

The title expresses exactly what is the range of subjects treated. The largest part of the essay is occupied with tropical cyclones and temperate storm-areas. The views at present current among meteorologists as to their nature, structure, and motions are clearly and succintly stated. Desert whirls are the simplest forms of cyclonic disturbances of the air and are used as an introduction to the consideration of the more complex cyclones. Tornadoes are briefly discussed at the conclusion.

Maps and diagrams are freely used and the whole forms a neat, attractive and trustworthy statement of the characteristics of atmospheric up-pours. The book deserves a general sale and, for the parts of meteorological science to which it is devoted, it could properly be put into the hands of students. It is written for the general reader, though not popular in the sense in which that word is usually employed. To those who wish an introduction to modern meteorology we can recommend this book as the most suitable for their purpose. The only suggestion we can make is that an explanation of the method of employing the storm areas in weather prediction would add to its usefulness.

CLIMATOLOGY.

Mr. I. C. Russell's "Sketch of the history of Lake Lahontan, a quaternary lake of northwestern Nevada," edited by Mr. J. K. Gilbert, and recently published in the third annual report of the United States Geological Survey, contains some discussion of the climatic conditions and

changes that have recently prevailed over our western territories. As these were apparently cöincident with the glacial epochs of the northeastern part of the country, they are of importance in the more general considerations of the earth's climate. Mr. Russell concludes from a study of the lake deposits and terraces that there have been within quarternary time, two cool and humid periods during which the lake basin was deeply flooded, and three warm and dry periods—pre-Lahontan, inter-Lahontan, and post-Lahontan, or present,—during which there were conditions of aridity like those now existing. The disappearance of the lakes, when evaporation exceeds supply, is thus held to depend on an excess of warmth; a long maintenance of summer-like conditions. The filling of the lakes when supply exceeds evaporation, corresponds to a lack of warmth; a long maintenance of wintry conditions. The latter condition need not have been one of heavy rainfall; it may have been of but moderate humidity coupled with a low mean temperature and a consequent slow rate of evaporation. This corresponds with Mr. Gilbert's previous conclusions derived from the study of Lake Bonneville, of which Great Salt Lake is the present remnant, as published in the preceding annual report of the Geological Survey; and corresponds further with the present interpretation of the glacial deposits of the St. Lawrence region.

From the studies of these geologists, it would seem that no geographic changes, such as mountain growth, can be held accountable for the climatic changes. The cause of the latter must be looked for away from the earth.

Another part of Mr. Russell's report that should find mention here is his admirable description of the peculiar optical effects characteristic of the desert plains and valleys of Nevada, with the change from the blinding glare of cloudless noon to the oblique and tempered light of evening; and again his account of the succession of the seasons.

Indeed the entire report should be studied by those interested in the broader aspects of climatology.

W. M. D.

THEORETICAL METEOROLOGY.

Theoretische Meteorologie. Ein Versuch die Erscheinungen des Luftkreises auf Grundgesetze zurückzuführen. By Albert R. v. Miller-Hauenfels, Professor in Graz, with a prefatory letter by Dr. Julius Hann, Director of the Imperial Central Institution for Meteorology and Terrestrial Magnetism at Vienna. Vienna, 1883; 129 pp; 13 figs.

It is generally agreed that an imperfect theory, or even a false one, is better than no theory at all in the development of a science. The theory gives the investigator a definite aim and he endeavors to prove or disprove it, while in the absence of a theory he wanders aimlessly and has very little probability of stumbling on an important fact. But much depends, of course, on how far the theory is in accordance with known laws and facts and in how far it is the work of pure fancy. Theories of the former sort require a high order of talent in their makers and deserve respectful consideration, while those of the pure imagination are very easy to make and may be dismissed with little attention.

This author belongs to the first class of theorists and, in this little book, he has built up a system fairly in accordance with known laws and facts and capable of explaining many phenomena heretofore considered enigmatic. The general characteristic of the work is the employment of several theorems in the physical theories of gases and heat in their modern forms. He insists that the fundumental laws of meteorology are those called Mariotte's and Gay-Lussac's giving the relations of density, temperature and pressure of gases. He employes the lines of equal density (isosters) in the place of the lines of equal pressure (isobars) and many of his most important results are thus derived.

Another fundamental idea in his theory is that of considering that part of the ver-

tical hydrostatic pressure of the air which is independent of the centrifugal force and change in gravity as a distinct element in meteorological changes. This he calls the "Auftrieb," (which we translate as "lift") of the air. It is on account of this "lift" that the isobars and isosters do not fall together and the lift may vary without causing horizontal motions of the air. The general distribution of the lift over the earth is considered, and its relations to the equilibrium of the atmosphere are discussed.

A third fundamental idea of the work is that the energy of insolation may be resolved into a vertical and a horizontal component. The former affects the lift, the latter is considered the "long-sought" wind-force.

With these and some other minor fundamental ideas, the author draws the following general conclusions: First, the atmosphere is sharply divided into two parts. The outer he calls "telluric." In it the winds do not occur; its isoteric surfaces are concentric and constant. The inner is the "meteoric." It is not more than 5 or 6 miles thick, is in contact with the surface, is constant in quantity, and in it the meteorological phenomena occur.

Second, each surface minimum of pressure has above it, well up near the lower surface of the telluric atmosphere, a corresponding maximum, and each maximum has a corresponding minimum above it. The two together form a "disturbance," and the disturbance is "negative" when the minimum is at the surface and maximum above; "positive" when the maximum is at the surface and the minimum above. The disturbances may be axial, ring-shaped or girdle-shaped. The ordinary "low-centers" are negative axial disturbances, the "high-centers," positive axial, the trade system forms, each side of the equator, a negative and positive girdle, and the author thinks that some thunderstorms are negative axés with positive rings concentric to them. Negative and positive disturbances supplement each other. The wind blows out of the second into the first at the surface, and reversed above.

With the aid of these conceptions and a use of mechanics, which is so direct and easy as to show that he is at home in that subject, the author proceeds to dissect the trade system of winds and the axial disturbances and to follow the path of a particle of air through each. The progressive motion of the axial disturbances is then discussed and mechanical causes are found to give the motion in the proper directions and to be capable of producing so much greater velocity than we actually find that the difficulty is to tell why they do not go faster. The theory which makes this motion depend on the relative condensation in different quadrants is referred to, only to be dismissed with the statement that it is not as yet capable of analytical expression. The differences of temperature and pressure actually observed in different quadrants of a minimum are explained without reference to the character of the entering winds.

The work is terminated by a discussion of atmospheric tides. The solar ones are to be seen in the diurnal variations of the barometer, somewhat masked by the varying temperature and density. That the lunar tides must be appreciable he does not doubt, but the proper method of investigation has not yet been employed.

The above sketch will not give so favorable an impression of the book as may be obtained by a careful reading. The physical propositions on which his conclusions depend and the ascertained facts which they explain are necessarily omitted here, but they receive their due share of attention in the work itself. Dr. Hann, in his prefatory letter, gives a cordial reception to the book, but indicates that the cases considered are rather ideal, but yet worthy the sympathetic attention of meteorologists. We close the book with the belief that, while many positions taken by the author will not be accepted without contest and some not at all, yet the whole forms an important addition to meteorological literature. It is full of

suggestion from beginning to end and when we are able to decide conclusively, for each position taken by the author, that it is true or not true, meteorology will be advanced far beyond its present status.

LITERARY NOTES.

—Professor F. H. Loud publishes a monthly weather report for Colorado Springs, Col., in the *Daily Gazette* of that place. The latest reports were for March and April in the number of that journal for May 10. The mean temperature for these months was slightly lower than for the last seven years. On April 22 the thermometer fell to 8.5°.

—We owe to the health officer, Mr. C. W. Rowland, a copy of the latest annual report of the Health Department of Cincinnati. The flood of 1883 was followed by a slight reduction in the general mortality, but there was considerable increase in deaths from lung disease, and the localities affected point strongly to the flood as the cause of the increase. Since the last flood the parts of the city which had been submerged have been thoroughly cleansed and the death-rate has been very low.

—Captain v. d. Gröben, in a long article in the *Journal of the Austrian Meteorological Society*, uses the records of the outflow of the Mississippi River, to test Meldrum's law of the coincidence of rainfall and sun-spots. The law may be stated: maxima of precipitation occur with maxima of sun-spots, and minima with minima. A careful comparison of the records fails to show the coincidence required by the law, but the author proceeds to point out that the disturbing effects of wind and storms would mask any coincidence that might exist. He thinks that the coincidence could be demonstrated only in exceptionally favorable cases as on tropical islands and on favorable tropical coasts, and here he thinks, the demonstration is already so clear as to be beyond reasonable doubt. It seems that sun-spots will not help in the prediction of floods in the temperate zone.

—In a heavy gale which occurred Dec. 10–16, 1883, at Liverpool, Mr. Isaac Roberts compared the variations in height of the barometer and underground water; the results are published in the February number of *Symons's Meteorological Magazine*. The barometer and water-level were found to change in an opposite direction and the water was thought to be on the whole more sensitive. The water was from triassic rocks, but the distance below the surface is not given.

—The February number of the *Journal of the Austrian Meteorological Society* contains a very appreciative notice of the report of the Chief Signal Officer for 1881. Especial attention, with warm approval, is called to the evident sympathy of the present head of the Service with the scientific (as distinguished from the purely practical) pursuit of meteorology. The suggestion is made that the value of the report would be increased by dividing it into three volumes, one for details of administration, a second (quarto) for the meteorological summaries, and a third for the appendices.

—Apropos of the effort of the Signal Service to form an extensive corps of thunder-storm observers, it may not be generally known that a society for that purpose was formed in Germany with its center at Halle, in 1820. Our information concerning it is derived from Hellmann's Repertorium. Schweigger, then professor of physics at Halle, originated the idea, which was received with some enthusiasm. In 1821 the society had 52 stations, but they gradually dwindled in number until 1825, when it became extinct. The results seem to have been unimportant. We may fairly expect something much better now that we have clearer ideas as to the character of the larger disturbances.

The general current of German meteorological literature began in 1640, and grew but slowly until about a century ago. There were some irregularities from time to time—small waves on the general current, until 1770 when a flood-tide set in. With some retrogressions the flood has grown with increasing rapidity up to the present time. In the 16th century the German meteorological contributions averaged 6 per year; in the 17th 7; in the 18th 15; in the 19th 66; and in 1881 the contributions numbered 176.

—The Hydrographic office, at present, in addition to many other things, is preparing seven volumes of light-lists containing all the lights exhibited for the benefit of navigators in all parts of the world; two volumes of sailing directions of Newfoundland and Labrador, and of the Caribbean Sea, and the Gulf of Mexico; ten volumes of supplements to sailing directions of all ports of the world, and a catalogue of the publications of the office. It has prepared and published 200 notices to mariners embodying information from all parts of the world, quarterly reports of publications, and twenty new charts.

—The June Pilot-chart, from the Hydrographic office, is at hand promptly on June 4. During May the icebergs continued their unusual southern extension, being found as low as 42° latitude in longitude 48°. A remarkable phenomenon is the occurrence of field-ice off Gibraltar, in latitude 36° 19^{m}, longitude 11° 20^{m} west, where it was encountered by the British steamship "Inflexible." The vessel was four hours in passing through it. The date is not given. There were four waterspouts reported, viz.: May 3 in lat. 22° north, long. 56° west; April 26, lat. 33°, long. 69°; May 14 and May 16, off Cape Henlopen. We understand that these charts will cease after July 1 on account of lack of appropriation. This will be a source of very great regret to navigators and meteorologists. The expense of the charts is not great, and to cut them off is, on the part of Congress, to be penny-wise and pound-foolish.

—Circular No. 110 of the Illinois Department of Agriculture contains the meteorological summaries for April as deduced from the reports of twenty-one observers. Thunder-storms prevailed over the state about April 14 and April 26–29. The thunder-storms of April 1 were less general but more violent. In Christian county they were accompanied by hail; the stones were as large as a hazel-nut, and the fall lasted ten minutes. At Anna, Union county, a lightning stroke April 1, killed a horse and set a barn on fire.

—Le Verrier directed especial attention to thunder-storm observations in the French meteorological service about 20 years ago. The Scandinavian, Belgian and Italian services followed soon, and in 1879 the Bavarian service established a compact network of stations for this work. One of the best descriptions of individual thunder storms that we know is to be found in Mohn's text-book of meteorology, unhappily inaccessible as yet to those who do not read German or Norwegian. There is hardly a greater service which could just now be done to meteorology, which is within the reach of ordinary observers, than a life-history of a good typical thunder-storm.

—Mr. John Tatlock, Jr., of Madison, Wis., sends us two studies of *barometric measurements of altitude* in the White mountains; both are reprints from *Appalachia*. The first paper relates to the variation of barometric altitude with the season. The author uses the mean pressures and temperatures of the Signal Service on Mt. Washington and at Portland, Burlington and Boston, and compares the monthly values thus derived for the altitude of Mt. Washington. It is generally understood that the results for barometric altitudes are always lower in winter, but Mr. Tatlock finds the reverse uniformly true in this case. He does not attempt to assign a cause for this curious anomaly. In the second paper, an attempt is made to arrive, by means of the method of least squares, at a value of the numerical coefficients in the barometric

formula of Laplace which shall better represent the data. The results, however, do not justify the labor expended.

—The tornadic storms of March 25th, were hail-storms in Tennessee and stones were reported varying from the size of partridge's to hen's eggs. At Kingston Springs the rainfall was 1.69 inches within 30 minutes and the storm resembled a "water-spout." We would be glad to know if the resemblance consisted only in the heavy rainfall or in some cloud taking the familiar form well-known to every sailor. If the former, the comparison is unfortunate, if the latter it is of considerable interest and deserves further description. We think that this phenomenon may be one to which "cloud-burst" might be appropriately applied. No one seems to know exactly what a "cloud-burst" is and as so striking a metaphor ought not to be lost or given up to careless use, it might properly be applied to excessive and sudden precipitation of brief duration.

On April 14th the precipitation was of the heavy character usually notable in an area where tornadoes may develop. For that day it averaged 2.38 inches over the entire state. Some curious suggestions come out if we compute what the amount of water must have been and compare the action of the air in suspending it with the locomotive power in the state. The most easily accessible estimate places the surface of Tennessee at 45,600 square miles. If the water fell to the depth of 2.38 inches the total fall was about 30 million gallons or 247 million pounds. If we suppose each railway car to carry, on the average, 10 tons and 25 cars to make a train it would take 454 trains to draw the water which the atmosphere precipitated on that day in Tennessee. That is probably upwards of four times the locomotive power actually employed in the state on that day. The condensation and precipitation of this water implies the transformation of a far greater amount of energy than is represented solely by its weight, and it is now easy to see how the gentle atmosphere may sometimes develop a tornadic power. Indeed when it carries in its bosom such mighty forces, it is not easy to see why it does not more often develop such storms.

—We have received from the Hon. A. T. McWhirter, Com., of Agriculture, the Tennessee Crop and weather reports from November to May. They are fine attractive looking pamphlets with covers of different colors and are an improvement in appearance on the usual weather report. The latest gives results from 42 stations. In the earlier numbers the precipitation is graphically represented by a series of vertical lines; in the last (April) we have two maps, one of precipitation, one of isotherms and winds. In each number we are given the summaries for the principal meteorological elements, and remarkable phenomena are noted.

—The Dutch government at Batavia last October appointed R. D. M. Verbeele to make an examination of the effects of the Krakatoa eruption, and his preliminary report—*Kort verslag over de nitbarsting van Krakatau op 26, 27 en 28 Augustus, 1883, Batavia, 1884*—has recently been received. The times of the most violent explosions is of importance to meteorologists in their study of the atmospheric waves that spread around the earth from the volcano as a centre. These are given as 5:35, 6:50, 10:05, 10:55 (Batavia time) on the morning of August 27. Of these, that of 10:05 was the heaviest. The times were not determined from barometric records, as there was no self-registering barometer at Batavia, but from an automatic pressure gauge in the gasometer of that city. The tracing on the rotating cylinder for Aug. 26–27, showed a sharply broken line instead of the normal curve. The times of wave-passage thus indicated were corrected first for an estimated interval (not given in the report) required for the response of the gasometer to the change of external pressure; and second for the passage of the waves from the volcano to Batavia. This second correction amounted to seven minutes; being determined by accepting for the wave a

velocity equal to that of sound, as the European and American observations seem to prove. These corrections are included in the times above quoted. Further notes on the distance over which the sound of the explosions was audible—3300 kilometers—and the general action of the eruption are given in *Science*.

W. M. D.

—We have received from the Hon. Ralph Abercromby reprints of three papers read before the Royal Meteorological Society. The first relates to the *diurnal variation of wind and weather in relation to isobaric lines*. The author summarises the paper as follows:

By constructing synoptic charts at different hours of the same day, and by comparing the wind and weather records at the different hours, and examining their relation to mean curves of diurnal variation, it is shown:

1. That the mean diurnal increase of the wind's velocity is explained by the fact that for the same gradient there is more wind by day than by night.

2. That the mean diurnal veering of the wind is explained by the fact that in cyclones the wind is a little more incurved and in anti-cyclones a little more outcurved, by night than by day.

3. That the mean diurnal increase of the frequency of rain during the day hours, in countries where the bulk of the rainfall is cyclonic, is explained by the fact that in any given cyclone the area of rain is larger by day than by night.

For every element it is shown that the diurnal changes are superimposed on the larger general changes, and that they are independent of each other. Great stress is laid on this point, both as explaining and classifying many meteorological questions, and as simplifying the problem of weather forecasting.

A simple hypothesis is suggested, from which it appears that the diurnal veering and increase of rain follow as a natural consequence of the diurnal increase of velocity.

In the second paper is a discussion of the vexatious subject of the *reduction of wind records*. The significance and best means of deducing the following nine facts are given, viz: the total quantity, the quantity from each direction, the relative frequency, the mean and the diurnal velocities, the mean velocity from each direction, the resultant, and the mean and the diurnal directions. The paper contains many suggestions of value on a thorny topic.

The third paper relates to a subject on which Mr. Abercromby has already made important studies, viz: that of meteorological explanations of *popular prognostics*. His previous paper related to those which can be grouped about isobars and cyclones. In this paper he considers those which can not be associated in these ways. They relate to diurnal phenomena, the sun, moon, and stars, sky, wells, underground water, etc. Much curious information is brought to light, and the explanations are such as commend themselves at sight. Naturally, some of the signs are local, and many of those mentioned would not apply to the United States.

—Hellmann's *Repertorium der Deutschen Meteorologie*, (Leipzig 1883) is a bibliographical work of unusual value. In the alphabetic list of authors—which is so complete that we have been unable to detect any omission—we have not only the list of their papers brought down to 1882, but also brief biographical notes to the same date. This is followed by a topical reference list, synoptically arranged. Then come the lists of observations and observers. The book closes with some historical and statistical notes. We find nowhere in these 500 pages, a list of periodicals in which meteorological papers appear. Any information one desires on this subject he can get only by leafing over the various lists. Such a list would be of great bibliographical value and the space required for it could have been saved by references to it.

The statistical part is curious and interesting. Sixty per centum of the authors contribute but a single article to meteorological literature; the remaining forty per centum range from 2 to 209. The last is, of course, Dove, but Lamont (190), Mühry (109) and Prestel (100), show a sufficiently remarkable literary activity. A very curious comparison can be made with the astronomers of greatest literary activity. As given in Houzeau's Biblio-

graphie, the literary astronomers are not generally the working astronomers. It would be hard to find, however, a more worthy list of four names in meteorology, than that of the four most fertile writers. Dove died at the age of 76. Lamont at 74 and Prestel at 71. Mühry, now at the age of 73, may still add much to his list. Dove's literary activity began at the age of 23, reached its maximum at 55, then gradually decreased until 73 when it ceased.

—"Whene'er the Sons of Leda shed
Their star-lamps on our vessel's head,
The storm-winds cease, the troubled spray
Falls from the rocks, clouds pass away,
And on the bosom of the deep
In peace the angry billows sleep."
—*Horace, Odes, translated by Brewer.*

"From Cloddipole we learn to read the skies,
To know when hail will fall, or winds arise;
He taught us first the heifer's tail to view,
When stuck aloft that showers would straight ensue;
He first that useful secret did explain,
That pricking corns foretell the gathering rain;
When swallows fleet soar high and sport in air,
He told us that the welkin would be clear."
—*Gay, Pastoral*, (1714.)

The above seem to have escaped the attention of the compiler of the "Weather Proverbs." The Sons of Leda are undoubtedly St. Elmo's fire. We observe in the "Weather Proverbs" that cats are classified with birds, and snails with insects and that the pleasantly versified "Reasons for not going Hunting" are attributed to Dr. Janner, under which name some may not recognize the genial physician, naturalist and musician, Dr. Jenner, the discoverer of vaccination. The original, by the way, was entitled "Signs of Rain." We consider Swainson's Weather "Folk-lore" (Edinburgh 1873) as the best book on this curious and interesting subject. He gives parallel proverbs in many languages and also a bibliographical list of about forty titles. For those who care to go farther back, Aratus' weather forecasts have been recently translated by Poste and published in London.

—A study of twilight and its colors under ordinary conditions is just now very opportune, after the highly colored twilights we have just passed through. Such a study has been made in Spain, by Dr. G. Hellmann, who has published his results in recent numbers of the *Journal of the Austrian Meteorological Society*, of which we have received a reprint. Dr. Hellmann's study falls into two distinct parts, geometrical and physical.

The geometrical part relates to the depression of the sun at the time of disappearance of the twilight-arch. The individual observations were very numerous and lead the author to the following results:

1. The sun's depression at disappearance of the twilight-arch, has a marked annual variation, with a winter maximum and summer minimum.

2. It is greater in the morning than in the evening.

3. It increases with increased relative humidity, and *vice versa*.

4. It is 15.6° in Spain, 15.9° at Athens, 15.6° on the Atlantic ocean from 18° north to 20° south latitude. It is greater in higher latitudes than in lower, and must be less in deserts than on the ocean.

5. Since the depression of the sun is periodically variable, the usual solutions of the problem of shortest twilight are defective.

In the physical part of the investigations, Dr. Hellmann found greater difficulties, chiefly in defining what he saw and comparing it and the observations made by others. There are two distinct sorts of physical twilights,—those of the wet and those of the dry season. The former are especially characterized by greater brilliancy of coloring. The phenomena are more brilliant and more sharply defined in Germany than in Spain. In the latter country the green is a very common twilight color, while it is exceptional in Germany; on the other hand the reds are more pronounced in Germany.

The paper is replete with references to ancient and modern literature on this sub-

ject, and altogether makes a valuable addition to our knowledge.

—Number 37 of the current volume of the *Boletin del Ministerio de Fomento* of Mexico contains the tabulated results of magnetic observations taken at the Central Meteorological Observatory in the City of Mexico for December, 1883. The synopsis for January, 1884, appears in No. 40, and that for February in No. 43.

In No. 40 appears the general synopsis of the meteorological elements for 1883, for the same station. The mean pressure was 586.42^{mm} (not reduced to sea-level) and the extremes 592.43^{mm} and 580.13^{mm}. The mean temperature was 15.2° C. (59.4° F.), the highest temperature 30°.0 C. (86 °F.), the lowest −3°.3 C. (26° F.). This gives a temperature which is remarkable for a locality in latitude 19° N., but it must be remembered that the elevation of Mexico City is 2282.5^{m}. The climate of the city is also very dry. The humidity averages 0.62 for the year. This is given as 0.69, but the average of the monthly means is 0.62, and the highest monthly mean (September) is 0.71, the lowest (April) being 0.42. The mean diurnal evaporation in sun and shade is 5.5^{mm} and 2.2^{mm} respectively. The total number of rainy days was 167 and the total rainfall 608.7^{mm}. The days on which lightning was seen were 146, which seems a remarkably large number. The sky is not so clear as the dryness would lead us to expect as the average cloudiness for this year was 0.55.

—The *Monthly Weather Review* for March is at hand. Of the areas of low barometer for the month, No. III is of interest from the fact that it was joined by a second in southern Texas, while No. IX is noteworthy for the reason that it divided into two while in Washington Territory. Of these two, one passed northeast into British America, when it was lost, while the other passed down to New Mexico, thence nearly direct to the Gulf of St. Lawrence. No. VI was traced from the Pacific coast, over the Gulf of Mexico, along the Atlantic coast, then across the Atlantic to the west of the Scottish coast, when we lose sight of it. Its path traversed upwards of ninety degrees of longitude and thirty of latitude. It was mild in the Gulf, rainy and snowy on the coast, and developed hurricane characters on the Atlantic. The lowest temperature observed was −27° for Escanaba, Mich., and St. Vincent, Minn. The lowest March temperature ever noted in the United States was at Fort Benton, Montana, where the thermometer reached −42° in 1876. The greatest monthly range was 82° in Montana and Dakota. The greatest daily range was at West Las Animas, where the change was 53°. A notable fact is that on Pike's Peak, not far distant, the greatest daily range was only 23°. The red sunsets were still observed in about half the states.

CORRESPONDENCE.

AIR PRESSURE AND THUNDER-STORMS.

TO THE EDITOR:—Your agitation of this question introduced by Mr. Paul in the May number of this journal has interested me very much and I think should be continued. The fact of a rise in pressure attendant upon thunder-storms has been often noted by those having charge of autographic barometric registers but they have been little studied. While not prepared to discuss the subject exhaustivly, I desire to call attention to two points that have attracted my attention:

On p. 24, this journal, Mr. Paul gives a curve showing a rise of pressure during disturbances from 3 to 4 p. m. Now this is just the time when there is a minimum in the diurnal range of pressure amounting at Washington to about .07$\frac{1}{2}$ in. below the a. m. maximum. Taking this fact in consideration we see that this rise is far more abnormal than appears at first sight.

A second point is that a thunder-storm is ushered in repeatedly by a strong wind from the direction from which it is coming, and this too though the wind may have been from an entirely different direction just previously.

This will be recognized as contrary to the usual direction of the wind which is *toward* an approaching disturbance. Many explanations have been sought for this apparent anomaly, such as the cooler and denser air flowing out from the thunder-storms, the effect of a down pour of rain &c. These explanations however do not explain the phenomena as satisfactorily as the view of a greater pressure immediately at the centre of disturbance. As the usual theory assigns a lower pressure for the centre of a thunder-storm it is important to establish or overthrow it.

H. A. HAZEN.

[The observation of the use of the barometer with thunder-storms is now over a hundred years old. It was observed by Planer in 1782, and was published by Rosenthal in 1784. A notice of it can be found in Poggendorff's Annalen, XIX, 1830, and Kaemtz has not overlooked it. See Hellmann's Repertorium and in the Austrian *Zeitschrift* page 43 of the current volume.

That the rise is not due to precipitation is shown by the fact that we have the rise with "dry" thunder-storms. Besides the problems suggested by Mr. Hazen, and by Mr. Clayton in our June number, there are many others of quite as much interest and importance connected with thunder-storms.—ED.]

TO THE EDITOR:—I have been looking for some time for some mention to be made in the scientific journals of an appearance in the heavens about the 10th or 12th of November 1883.

The phenomenon in question was a vertical streak of light in the S. W., about 30° above the horizon, about 15° in length, red in color, very much condensed in the centre, and at that point quite bright, much resembling a comet with two tails, one pointing downward, and the other upward, the tails both spreading to a considerable width at the extremities. I turned a four inch telescope on it in which it was visible for over an hour, and then gradually faded away. I have spoken with a number of persons who saw it, and the distance of the point of observation of some of them from mine, show it to have been at a considerable distance, as, to them it occupied the same place in the heavens that it did to me.

Inclosed find drawing giving a general naked eye view of the object as a whole, with telescopic view of the nucleus, (magnifying power 20.)

Yours Respectfully,

JACOB RICE.

P. S.—I would remark that it was about at the beginning of the red sunsets.

TO THE EDITOR:—I wish to make an inquiry, and trust I will be condoned for so doing as I have only recently begun the study of meteorology. In the June number of the AMERICAN METEOROLOG-

ICAL JOURNAL, page 42, you say: "The two effects are now well known to depend chiefly on the attitude of the observer with respect to a passing cyclonic storm. The wind *hauls*, if he stands on the right of the track, it *backs*, if he stands on the left."

My inquiry is, in which direction is the face of the observer, toward the north, or east?

Please answer and greatly oblige one deeply interested in the study of Meteorology.

Very Respectfully,

J. C. E.

[The right-hand side of the path is that toward the right of a person standing in the path and looking in the direction of the progressive motion.—ED.]

PUBLISHERS' DEPARTMENT.

From the numerous letters which we have received commendatory of the AMERICAN METEOROLOGICAL JOURNAL we publish the following, as they both contain suggestions worthy of notice:

GLENWOOD, IA., May 24, 1884.

W. H. Burr & Co., Detroit, Mich.:

DEAR SIRS—Find enclosed $1.50, for which send me the Meteorological Journal on trial for six months; presume I shall want it longer. I think it will meet a want we amateurs have felt for a long time

Yes, let us have a meteorological society. All other professions and branches of science have an organized corps of workers, why not the meteorologists.

Respectfully,

SETH DEAN,
County Surveyor.

OAKLAND, CAL., May 19, 1884.

W. H. Burr & Co., Detroit, Mich.:

GENTLEMEN—Inclosed please find subscription, $3.00, for the *American Meteorological Journal.*

What will be the result of your undertaking to publish a meteorological journal is hard to tell, but one thing is certain, the scientific world needs such a publication to record the many facts and observations which are daily taking place in this department of physical science.

The only way for your enterprise to succeed is for your subscribers to send the one thing needful *at once*, so that you can start off with strength and encouragement.

Yours truly,

J. B. TREMBLEY.

The attention of those wishing work of any kind in the Engraving line is called to the advertisement of Wm. Bertram, of Chicago, in this number. Mr. Bertram makes the engravings for the AMERICAN METEOROLOGICAL JOURNAL and his work is very satisfactory both as regards quality and price.

The fortnightly *Index* of Ann Arbor, Mich., has recently enlarged its sphere and announces itself as the medium of communication between the University of Michigan and the leading teachers and scholars of the country. Profs. Winchell, Adams and Payne of the University corps of teachers have been added to the editorial staff of the *Index* and other arrangements have been made to make the paper all it aims to be.

CORRECTIONS.

Page 8, line 17 from bottom, for "southwest" read "northwest."

Page 26, line 14 from top, for "rounding" read "bounding."

Page 37, line 3 from bottom, for "pressure" read "vessel."

The note at the bottom of p. 75 should have been credited to *Science*; the following correction is from the same journal:

In our last issue we were in error in stating that the board of managers on the Yale college observatory had been abolished. The president of the college has been added to the board, but no decided change in the organization of the observatory will be made till he has become personally acquainted with the needs of the institution.

The author of the notice of Mr. Scott's Meteorology, in the June number of this journal, regrets that he misapprehended a passage concerning the action of water in absorbing and radiating heat. He was under the impression that the high specific heat of water was referred to as the reason for its slow change of temperature; a more careful reading shows that the statement was concerned rather with the imperfect diathermancy and correspondingly low radiating power of water, in which peculiaritics it stands between solids and gases. The exception taken to the first quotation from Scott's book is therefore incorrect and should be erased.

W. M. D.

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ANNOUNCEMENT OF THE FORTNIGHTLY

INDEX

AN INDEPENDENT JOURNAL OF LIBERAL EDUCATION.

A plan has long been in contemplation to establish at Ann Arbor, the seat of the University of Michigan, a journal of high character, that should reflect the maturest thought on educational, literary, scientific, artistic, political and historical questions of current interest. The presence and the influence of this great center of learning seemed to afford unusual facilities for carrying forward such an enterprise; and it was felt that an institution of so great influence in moulding the education of the West should have some recognized medium of communication with the leading teachers and scholars of the country. Through a series of steps not necessary here to describe, the fortnightly INDEX, now entering upon its third year, finds itself in a position to undertake the mission just indicated; and the attention of the educational public is invited to the announcement we now have to make.

By an arrangement recently completed with Professors Alexander Winchell, Charles K. Adams and William H. Payne, of the University of Michigan, these gentlemen have been added to the editorial staff of the INDEX; and the paper will be conducted hereafter in accordance with the following general plan:

I.—*Alexander Winchell, LL. D.*, Professor of Geology and Palæontology, will take in charge the department of Science and Arts, and by way of editorials, notes and leading articles will present regularly a careful digest of whatever is most valuable in these important domains of knowledge. There is a growing recognition of the value of science in all schemes of public education; and Dr. Winchell will discuss the various phases of scientific intelligence and instruction.

II.—*Charles K. Adams, LL. D.*, Professor of History, and Dean of the School of Political Science, will write upon current affairs and upon such Historical themes as bear on matters of present political and educational importance. He will also discuss another class of subjects now assuming a deserved prominence—the training of the young for the duties of citizenship through suitable instruction in Political Science; and the need of diffusing among the people at large correct ideas on governmental and municipal administration.

III.—*William H. Payne, A. M.*, Professor of the Science and the Art of Teaching, will discuss the subject of Education in its three phases, the practical, the scientific and the historical. The treatment of these themes will be catholic and impartial. The purpose will be to expound the rational elements in scholastic questions, and to ally the methods of the school room with common sense as well as with philosophy.

IV.—The *Literary Department*, remaining in the same hands as heretofore, will continue to maintain a high standard of excellence. A trustworthy record of the latest publications will be presented; and a series of leading essays, and short poems of merit will be made prominent features.

V.—The *Department of Criticism* will be conducted in a spirit of judicial independence. Exhaustive review articles, and extended notices of important works and events of the realm of Art, written by specialists in their several lines, will express the critical judgments of men qualified to form an unbiased opinion.

VI.—*Letters from Foreign Correspondents* will contain intelligence of progress in different parts of the world. We shall allow our home correspondents ample space for the discussion of all questions that fall within the compass of a high class educational and literary journal.

VII.—The INDEX will be issued fortnightly, the subscription price remaining as before—$2.00 per year, prepaid. The publishers are encouraged to solicit subscribers among all persons interested in the maintenance of an independent journal of liberal education such as the INDEX, upon the broad plan here outlined, aims to be. For the present all subscriptions may be sent directly to the

INDEX PUBLISHING HOUSE, Ann Arbor, Mich.